

Electrochemical Possibilities
of the
Pacific Coast States

By

J. W. BECKMAN

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An Article and an Editorial

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Coast States as Compared with Those
of Sweden and Norway**

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together with an editorial on

**The Place Value of the Waterpowers
of the
Pacific Coast for Electrochemical Industries**

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Electrochemical Possibilities of the Pacific Coast States as Compared with Those of Sweden and Norway*

BY J. W. BECKMAN

To some of us the word electrochemistry has a mystic charm; it produces visions to the mind's eye of turbulent streams and waterfalls in the midst of peaceful forests, and also the vision of the electric furnace with its sputtering frenzy. It has a wide step from the waterfalls in the woods to the wild roaring of an electric furnace, but we all know that they stand in intimate relationship to each other. The power of the impetuously falling water is harnessed and transferred often hundreds of miles, silently and calmly over a wire, only to be let loose at the other end in often a wild though conquered shape, to produce products which a complex civilization has learned to be dependent upon.

To-day there may be dreamers who have visions of cheap electric power being produced in a way other than by water power. It may be possible to do this, but for the big electrochemical industries of to-day, and of the future, hydraulically produced power is and will be used. Therefore, the most important raw material of all electrochemical industries is an abundant amount of water seeking a lower level. Few locations offer conditions favorable to the harnessing of water for industrial purposes, and as a rule the mountainous countries are the water-power producing localities.

Lands that are known as hydroelectric power producers are various mountainous sections of Southern Europe as well as Sweden, Norway, and Finland in Northern Europe. The Western sections of the North and South American

*A paper read before the San Francisco Section of the American Chemical Society.

continents are, together with New Zealand and a few other localities, favorable to hydroelectric power developments.

It may seem strange to compare Sweden and Norway, countries old in the civilized history of the world, and from our point of view located on the globe practically at the North Pole, with the three Pacific Coast States, California, Oregon and Washington, but I believe there are many similarities, in spite of difference in relative position on the globe, that are in many respects quite startling.

I beg you to note that Sweden and Norway are about as large as the three States of Washington, Oregon and California. The population in Sweden is about five millions, and the three coastal States contain practically the same number.

Sweden has large sections along the coast which are comparatively flat, consequently the water power sites are located mainly inland, much the way conditions are on the coast. One-half of Sweden is wooded, while half of these three States is under timber.

Geologically the conditions are very different. Sweden is practically all of very ancient geological formation, while the coast is, as we all know, of comparatively recent formation.

In a general way conditions in Norway are similar to those in Sweden. The land is heavily timbered and filled with inaccessible mountains and valleys. In many places the streams drop right into the ocean, making power developments possible on tidewater, similar to the possibilities on our own coast in British Columbia and Alaska. The geological formation in Norway is of the same age as in Sweden. Norway has about three million inhabitants on the Scandinavian Peninsula.

The electrochemical possibilities in Sweden and Norway are great for two reasons only—one is abundance of cheap power, the other comparatively cheap labor.

Seven and one-half million horsepower are available in Norway at present, of which one-half million is developed, and an additional million horsepower is under development. When this power is developed it will amount to about 20 per cent of all available power.

The largest present, single operating installation is at Rjukan, where 131,000 hp. are developed and at the same place 119,000 hp. are being developed, which is the largest power development under way there at present.

There are two developments possible in Norway, each for 240,000 hp., but neither of them is even projected to be

developed. Many of the installations are in the interior and inaccessibly located, involving special means of transportation to reach them, often through sections of the country where power transmission is impossible, partly due to the nature of the country, and also due to climatic conditions.

However, in Sweden conditions are materially different. The heads are comparatively low and the nature of the country makes long transmission lines possible. The available power in Sweden is 6.2 million hp., of which at the present time 900,000 hp. are developed, about 15 per cent of total available power.

The largest single development in Sweden is that of the Swedish government at Trollhättan, in the Southern part of the country, where a total of 80,000 hp., is obtainable. The greater part of the Swedish developments are low-head and small-capacity plants.

If the power situation be considered in the Pacific Coast States, it will be found that there are available about 11,000,000, of which 7 per cent or 831,000 hp., have been developed. Most of the developments are high-heads, 500 ft. or more—a few exceptions there are—and among the most noted proposed low-head developments on the Pacific Coast is The Dalles development on the Columbia River, where about 800,000 hp. could be delivered. More than half this amount could be supplied twelve months of the year. The remaining power could be counted on for eight to eleven months of the year.

The Great Western Power Company is, in spite of having developed some 100,000 hp., still able to develop some 500,000 hp.

On account of local and climatic conditions in the coastal states, long distance transmittal is easy and comparatively cheap.

As the population is centered in the large valleys and along the coastal districts, the necessary length of power lines from generating stations, located in the mountains, to the consuming districts, are comparatively short, and the lines with few exceptions do not exceed 200 miles.

The cost of hydroelectric power is really a question of bookkeeping, and since each individual power plant has its pet way of calculating costs, it is impossible to compare the average power costs given with each other, not knowing how much, or how little, they include, what the interest rates are, etc. When a standard accounting method is adopted by all power plants all over the world, then the comparing of cost, per horsepower, may have some meaning.

When an industry develops its own power source the bookkeeping method can hide absolutely the actual cost of the power. On this account I am extremely sceptical as to the low figures quoted for the power some industries utilize in Norway.

The prices for power obtainable on this coast close to, or at the power site, do not vary materially from those in Sweden and Norway.

The prices in those countries are from about \$6 per horsepower-year, and up, provided large blocks of power are taken. In Norway with higher head developments the minimum price may be somewhat lower.

Compare these prices with that of less than \$10 per horsepower, quoted by the State of Oregon for power from the projected development at The Dallas, and I believe it will be agreed that cheap power is available here, as well as in Sweden and Norway.

Only recently the Great Western Power Co. has entered into contract with an electrochemical company for large blocks of power on tidewater at a rate that is as good as that which is obtainable at Niagara Falls. Niagara Falls is 500 miles from tidewater, which means a long rail haul. Power on San Francisco Bay at the same rate, means large savings in the way of transportation charges, etc.

The idea that there is an abundance of cheap labor in Sweden and Norway is to an extent a fallacy. Emigration is continuously draining the working stock of the people, and although the average daily wage is about \$1 to \$1.25, there is not a superabundance of labor, and the industries are often handicapped. Of course, in the more specialized industries, as the electrochemical, the price for labor is somewhat higher.

Compared with the cost of labor on the Pacific Coast, the Scandinavian prices are low. But the ultimate cost of producing electrochemical products, I believe, is no higher there than here, due to higher cost of raw materials there than we have to pay.

What, then, are the industries that have brought Sweden and Norway to the front in the eyes of the world as countries that take a foremost position in the electrochemical industries?

When artificial nitrogen fertilizers are mentioned, Norway with its nearly 300,000 hp., exclusively devoted to that industry, looms up. Calcium nitrate and calcium cyanamide are both products made in Norway; the latter is also made in Sweden. The raw materials for these products are: cheap power, the nitrogen of the atmosphere, and limestone. In case of the cyanide, coal is also needed.

In Sweden and Norway, plentiful, cheap power is available, though not always in accessible places as the large developments at Rjukan, in Norway show, located as they are in the most impenetrable part of the mountain fastness. Nitrogen is abundant; limestone is accessible, in some cases, though involving considerable haul by rail or water. The coal is all brought in from England, which means expense of handling and in addition duty on the importations.

The Pacific Coast States are in this respect as favored in many instances, as the countries of the Scandinavian peninsula. Take, as an example, the projected development at The Dalles; deep-water navigation is possible up to and beyond the proposed power site; limestone from Washington could be brought in cheaply, quarried as it is right on tidewater; coal from China, and eventually from Alaska could also be brought in and water transportation would be available for the finished product.

Similar conditions can be found at other localities on the Pacific Coast.

What has been said in regard to the fertilizer industries applies equally well to the carbide industries. Sweden consumes some 20,000 hp. annually in carbide manufacture and Norway, though I have no definite figure, consumes considerably more at the large works at Odda.

The Swedish iron is famous and well known over the world. There was a time, however, until quite recently that Swedish iron was beginning to lose its reputation. Scarcity of charcoal followed the increasing numbers of shaft furnaces in operation until gradually some of the iron masters of Sweden began to substitute coke with charcoal and the common coke pig iron was obtained with a result that the long established position held by Swedish iron in the markets of the world was fast slipping away. To-day, though, it is possible to increase the number of shaft furnaces in Sweden to three times as many as at present, without being obliged to use coke.

The reason is the introduction of the electric shaft furnace, in which two-thirds of the charcoal used for heating the charge in the furnace are replaced by electric heat. As the earliest blast furnaces were built in Sweden, so also Sweden first successfully solved the electric shaft furnace.

The iron industry of Sweden is located in a narrow strip 70 miles wide and 140 miles long approximately, the distance from Oakland to Sacramento. This small section of the country has brought, through its iron, fame to Sweden. As time goes along and the old blast furnaces have to be replaced with new, never again will an old-type furnace be placed in operation. Electrical shaft furnaces will be in-

stalled instead. There are now over a dozen of these furnaces in operation in Sweden turning out close to 50,000 tons of iron per year. The raw materials needed in electric shaft-furnace operations are cheap power, high-grade iron ore, good limestone and an abundant supply of charcoal.

Close to 1,000,000 tons of charcoal are burnt in Sweden annually, a great part of which is used in the iron industries. The charcoal is burnt all over the country and shipped into the iron-producing district by rail.

The greater part of the charcoal is produced in the old-fashioned way of heap-burning, though there is a strong tendency at present to replace the heap-burning by the large-unit by-product charcoal ovens, of which there are over twenty plants installed and operated. In this connection let me mention that at the Panama-Pacific Exposition there was a very excellent exhibit in the Swedish Building, of raw materials used and finished products obtained from one of these by-product plants.

Norway is also heavily timbered, but to very great transportation difficulties charcoal is not produced in such quantities there, nor do I believe they have any electric shaft furnaces in operation.

The iron ore is abundant in Sweden. Some has to be concentrated, since high contents of silica mean an excessive power consumption in the electric shaft furnace. The Northern ores from the large famous deposits near the Arctic circle average close to 70 per cent iron, and so do the concentrates from the more centrally located deposits.

Limestone is available though not always in close proximity to the shaft furnace plant.

Power is very often obtained from small hydroelectric developments, where enough energy is generated to operate a single furnace or purchased from a generating station.

What then are the conditions on the Western coast of the United States that would suggest the possibility of an iron industry growing up similar to that of Sweden.

The three coastal States have practically as much timber land as Sweden; the actual board measure would be much to the advantage of these States, since, due to climate and other conditions the growth in Sweden is quite light. Incidentally it is of interest to realize that Washington, Oregon and California to-day contain about one-half of all the timber lands in the United States. There are twenty-eight hundred billion feet of timber in the United States, while these three States have of this amount thirteen hundred billion feet.

By-product charcoal plants, close to the large lumber operations, should at present not only be the wise policy for lumber operators to follow, but should also give a good revenue from what at present is a decided nuisance and often a menace, and supply the needed charcoal for iron reduction.

It would take many years to develop 1,000,000 tons of charcoal per year on the West coast, but it is interesting to note that under conditions considerably adverse to our own this has been accomplished in Sweden.

Limestone is abundant all through the States, the quality of which is suitable for smelting purposes.

Iron ores of varying qualities, some of the highest purity, and others less pure, are available at many points in California and in adjoining States.

Power close to power sites and in the timbered districts, where charcoal could be cheaply made, is obtainable at prices which will make electric shaft-furnace operations not only successful, but financially profitable.

Norway and Sweden produce small amounts of ferro-alloys. The raw materials have to be imported. As an example, chrome ore is brought in from New Zealand.

The raw materials for such industries are right at hand in these States and can be had, in many cases, practically at no cost compared with prices paid for similar raw materials brought into Sweden and Norway.

Norway produces some aluminium from ore, part of which is imported and part is obtained from local deposits.

The Pacific Coast States have a very large supply of practically pure aluminium oxide awaiting treatment in waste piles, the aluminum oxide being a by-product in the potash production from alunite. Utah is one of the States where this by-product is produced.

Sweden produces considerable quantities of sodium and potassium chlorate. The raw materials have to stand heavy freight charges as they are imported from Germany. This is also the case in reference to salt used in the manufacture of caustic soda and bleach.

We are favored here by salt, which is readily available. It may be of some interest to know that a caustic soda and bleach plant is being built on San Francisco Bay.

Potassium chloride is to be had from Searles Lake, we hope at no very distant date. Meanwhile we may be able to get this salt from various waste materials available on the Pacific Coast, which are now being absolutely neglected.

An industry of special interest developed in Sweden is the electric reduction of zinc. Not less than 18,000 hp.,

producing close to 4000 tons of zinc per annum, are consumed in this industry. Ores containing both lead and silver, as well as zinc, are used in recovering the values.

Many of the ores of the West, which are now deemed practically worthless due to zinc content, could be advantageously treated in the electric furnace on the Pacific Coast.

An industry can never be a success if there is no market for its products.

Sweden and Norway together have a population, as mentioned before, of about 9,000,000 people, and since the greater part is a rural population there is a comparatively small demand for manufactured products. Therefore, foreign markets have been sought for the products of the industries.

There is no part of the globe that is not in some way dependent on products made in Sweden and Norway. This wide market field has been developed through necessity, and necessity has forced co-operation. Commercial agencies have been formed in foreign ports through which everything from Swedish lumber, sewing machines to electrochemical products have been sold. The different manufacturers have maintained these sales agencies jointly, and consequently the selling cost in foreign countries has been brought down to a minimum for the various products.

The nearby European markets are severely competitive, but they have been entered successfully. This has been possible for two reasons: quality of product and price of product.

Sweden and Norway, the latter especially, have learned the art of handling tramp steamers. Due to this fact, freight rates for products reaching foreign markets have been brought to a minimum.

It is equally possible for electrochemical industries, or, in fact, any industry on the Pacific Coast to penetrate foreign markets. We can reach from this point over one-half of the world's population by going West and South. Some of the markets are small, but are bound to grow, and if we miss the present opportunity somebody else will step in and collect the harvest which legitimately belongs to us.

The large electrochemical developments in Norway are financed by international capitalists, involving various complex problems, while here, if the needed capital cannot be procured on the coast, projects may be jointly financed by local as well as Eastern capital. This involves at the most a trip East with none of the complications that go with the use of foreign capital.

The Pacific Coast is endowed with raw materials that

may in time revolutionize some of the large industries; take, for example, oil so abundantly present in California.

Doesn't it seem like the intention of fate that large high-grade iron ore deposits, hydroelectric power and oil have been placed side by side? Can't we conjure up a new type of iron-reduction process where the iron is obtained from the ores by means of electric heat combined with the carbon and hydrogen in the oil, as reducing agent? I feel certain that the day will come when the Pacific Coast will be a factor in the iron markets of the world, due to the presence of these three agents.

Norway has about 500,000 and Sweden practically 150,000 hp. utilized in electrochemical and electrometallurgical industries. These have not grown over night. On the contrary, careful and faithful pioneer work had to be done not only in the laboratories, but among the population, and also in the Council Chambers of the nation. An electrochemical atmosphere has been produced; the layman has been brought face to face with it in perusal of his daily paper and gradually the population has grasped the fact that (though the details are perhaps hidden to the layman) electrochemistry is one of those mystic shrines by which, if treated with the correct signs known only to a few, new developments and wealths are produced.

We need an electrochemical atmosphere on the Pacific Coast. Up to the present time gold mining has been the atmosphere. Everybody knows what a placer mine or a gold dredge is; the papers are full of it. The large State universities of the coastal States as well as the daily papers, can assist in bringing this electrochemical atmosphere here.

Without fear of being refuted I will say that the Pacific Coast has more potential wealth in its 11,000,000 hp. of water power, of which 93 per cent goes to waste to-day, than all the gold that ever was mined or is still to be mined in these States.

Sweden and Norway are to-day looked upon as electrochemical centers. The Pacific Coast, I believe, will, within the lifetime of most of us, be looked upon as one of the large electrochemical centers of the world due to our being favored with abundant hydroelectric power and the varied and important raw materials needed in these industries and due to the enterprise of the men of this coast.

Electrochemistry is a young science in its present development compared with other sciences. The electrochemical industries are consequently young men's industries. Therefore, young men are needed, men with the pioneer's

optimistic resourcefulness and courage. But this alone is not sufficient; they need a special education which the large universities of this coast are bound to give if they are not already giving it to their students.

With the power, the raw materials and the men the Pacific Coast holds a mighty future in the field of electro-chemistry.

Great Western Power Company,
San Francisco, Cal.

The Place Value of the Waterpowers of the Pacific Coast Electrochemical Industries

In this issue we publish a very readable, enthusiastic and decidedly sensible paper by Mr. John Wood Beckman on electrochemical possibilities of the Pacific Coast States. This paper gives us a welcome opportunity to discuss in a few words the relative value of water-powers in different localities. Waterpowers have been very much talked about recently. With what has been said about the urgent need of removing the unwise and directly foolish legal restrictions which hamper the development of American waterpowers at present in the most serious manner, we fully agree. But we are somewhat under the impression that the owners of waterpowers in different parts of the country, together with the commercial interests depending on them, have not always taken a scrupulously correct attitude toward each other. There have been some indications of jealousy, or, shall we say, provincialism? It is perfectly natural that the owner of a waterpower thinks that his own waterpower is the most important. It certainly is for him. But we don't see the slightest justification for such jealousy as is natural between competitors in other lines. The reason is simply that as things are there can be very little competition between different waterpowers. The sphere of usefulness of a waterpower as a potential producer of an electrochemical product can be accurately figured from the cost of raw materials, operating cost, selling price and the very important item of freight charges from waterpower to market. Any waterpower has its own restricted market beyond which it cannot extend its usefulness economically, and it will be found that the market zones of the most important waterpowers overlap very little. All that is really needed in order to convince oneself of the truth of this statement is to tabulate the freight-rates from any one waterpower to the principal industrial centers of this country.

To give one concrete example which is rather extreme, we may refer once more to the present power famine in Niagara Falls. In order to find a remedy, it would be plain foolishness to think that the abundant and relatively cheap waterpowers of the Pacific Coast could be used as a substitute for Niagara power to supply the principal markets now supplied by the Niagara Falls electrochemical industries. The freight rates from the Pacific Coast to the manufacturing districts of the East and Middle West are prohibitive. Competition in this market between electrochemical products from Niagara power and from Pacific Coast power is therefore an economic impossibility. But has anyone ever seriously suggested this? Mr. Beckman's paper is just one more proof that the Pacific Coast clearly understands the situation and looks out for its own market. But if there cannot be commercial competition why should there be not a real attitude of mutual helpfulness between the waterpower interests of the East and the West?

There is a very simple fundamental reason why freight rates are of such enormous importance in determining the selling zone of a waterpower as an electrochemical producer. It is a well-known fact that the usefulness of so many electrochemical products is due to the stored energy in them. In other words, that the sale of so many electrochemical products is a case of chemical power transmission. But chemical power transmission, unlike electrical power transmission, depends on ordinary transportation means—railroads, ships, etc.—and this fact makes freight rates all important in chemical power transmission. And this is even more so in this country than abroad. In our issue of March 15, 1916, in discussing the place value of waterpowers, we gave indisputable figures showing that while this country is easily the foremost industrial nation, in that it has succeeded in multiplying the natural working productiveness of its average citizen by industrial development, yet, on the other hand, this country is very much less industrially populated than England or Germany, and the cost of transportation between the different industrial centers among each other and between industrial centers and sources of raw materials and markets respectively is very much greater. This consideration explains why in the chemical industries certain things are possible in Germany which are impossible in this country. It also explains why Niagara's antique position among American waterpowers is, to a large extent, due to its connection to the Great Lakes, with 3600 miles of shore line and navigable to the very docks at Niagara. The least expensive sort of transportation is thus provided for Niagara prod-

ucts to market representing nearly half the population of North America, while the least expensive supply of raw materials is provided in many cases by the same water way, quite aside from the railroads running from Niagara in all directions.

Now, what are the possibilities of electrochemical industries on the Pacific Coast? Mr. Beckman discusses this very question in an interesting way by basing his discussion on certain analogies between the conditions of the Pacific Coast and those of Sweden and Norway. Of course, the Pacific Coast States themselves offer at the start a ready market for electrochemical products, and this market will grow, but it is not large enough, nor will it be large enough for a long time to come in order to absorb all the products that could be made with the immense waterpowers available and waiting for development. Mr. Beckman is right: the Pacific Coast will have to follow the lead of Sweden and Norway and look for export trade and learn "the art of handling tramp steamers." "We can reach from the Pacific Coast over one-half of the world's population by going west and south. Some of the markets are small, but they are bound to grow, and if we miss the present opportunity somebody else will step in and collect the harvest which legitimately belongs to us."

Clearly, there are almost unlimited possibilities. But the amount of work that remains to be done to transform this vision into a reality is immense. Yet the pioneer spirit of the people of the Pacific Coast is just fitted for the task. When once the problem and the opportunities are realized; when, as Mr. Beckman puts it, an "electrochemical atmosphere" has been created, it may be safely left to the people of the Pacific Coast themselves to do the rest. The Pacific Coast has undoubtedly more potential wealth in its 11,000,000 hp. of waterpower, of which 93 per cent now goes to waste, than in all the gold that was ever mined or is still to be mined in those States. But an export trade must be created. The Golden Gate will then become the gate to a new and glorious future of the empire of the Pacific Coast.

